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Standards of Normal Weight in Infancy

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STANDARDS OF NORMAL WEIGHT IN INFANCY

COMMITTEE

CHAIRMEN:

Dr. J. E. A. Underwood, C.B.E., B.Sc., M.B., B.S., D.P.H. (until 1951).
Dr. P. Henderson, M.D., D.P.H. (from 1951).

MEMBERS:

Dr. Cecile H. D. Asher, B.Sc., M.D., M.R.C.P., D.C.H.
Dr. Georgie I. Brodie, M.B., Ch.B., D.P.H. (until 1952).
Dr. J. W. B. Douglas, B.A., B.Sc., B.M., B.Ch.
Dr. Katherine M. Hirst, O.B.E., M.B., B.S., D.P.H. (from 1952).
Dr. H. E. Magee, M.B., B.Ch., M.R.C.P., D.Sc.
Dr. E. Ann Mower White, M.R.C.S., L.R.C.P., D.P.H.
Dr. G. H. Newns, M.D., F.R.C.P.
Dr. Charles P. Pinckney, M.A., M.B., B.Ch. Camb., F.R.C.P.
Dr. Ian Sutherland, M.A., D.Phil.

E. R. Bransby, Ph.D.,
Secretary.

PREFACE

This survey had its origin in a request from the British Paediatric Association to the Ministry of Health that up-to-date figures should be collected on the growth of young children. In making this request the British Paediatric Association observed that the standards used in this country were based on figures collected at the beginning of the century or derived from American sources. We believe that the standards of normal weight in infancy obtained in the present survey and described in this Report are suitable for general use in infant welfare centres, hospitals, and general paediatric practice in Britain at the present time.

In order that representative standards might be prepared the survey was carried out in a number of localities in different parts of the country in co-operation with the Public Health Departments. We wish to record our sincere thanks for the ready and unstinted help given by the medical officers of health and their staffs, particularly the health visitors and the doctors of the welfare centres, who carried out the weighings and measurings and collected the other required information about the infants in the survey. The excellent nature of this information is itself a measure of the care and interest shown by the health visitors and doctors.

In the early stages of the survey the Committee was fortunate in having the services of the late Dr. Ethel Cassie, who shortly before had retired from the post of Senior Medical Officer for Maternity and Child Welfare in the City of Birmingham. She took an active part in planning and launching the survey and once it had begun, visited the welfare centres discussing progress and answering queries. Unfortunately, owing to ill-health, Dr. Cassie had to retire in 1950. The survey greatly benefited by her participation in the early stages.

We also warmly acknowledge the most generous co-operation of Dr. Georgie I. Brodie, particularly at the commencement of the survey and during the time it was getting under way. Dr. Brodie was a member of this Committee until her retirement from the Ministry of Health in 1951.

The General Register Office kindly undertook the coding of the illnesses experienced by the infants during the time they were in the survey and also of their fathers' occupations. We are most grateful to them for this assistance. During the course of the survey we consulted a number of experts on particular aspects and we especially wish to thank Dr. E. C. Fieller, Dr. W. P. D. Logan, and Dr. J. M. Tanner for their advice.

The general organisation of the survey and the analysis of the data collected were undertaken by Dr. E. R. Bransby and Dr. W. H. Hammond. It is hoped that the findings and recommendations which are presented in the Report with a minimum of detail, will readily be understood by those not familiar with statistical procedure.

The organisation of this large survey and the analysis of the data involved much office and computational work. We wish particularly to express our appreciation to Mr. T. O'Mara and Mr. K. G. Reeve for their most valued assistance.

P. HENDERON (*Chairman*)
CECILE ASHER
J. W. B. DOUGLAS
KATHERINE HIRST
H. E. MAGEE
ANN MOWER WHITE
G. H. NEWNS
CHARLES P. PINCKNEY
IAN SUTHERLAND

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I

INTRODUCTION

The standards of normal weight in infancy which are in most general use in this country are based on data of uncertain origin collected many years ago. Surveys of the physique of children which have been made over the years show that both infants and older children have become heavier and taller.

Parfit (1951) compared weights up to the age of one year of children born in Oxford between 1944 and 1948 with the " normal weights " on the charts issued for use in welfare clinics by the National Association for Maternity and Child Welfare and found that the majority of weights recorded in the Oxford study differed markedly from the so-called normal weights. Thomson (1955 *a*, *b*) found that compared with the infant weights reported by Paton and Findlay (1926) infants in Edinburgh in the 1950's, were, at the age of one year, about 2 lb. heavier.

Boyne, Aitken and Leitch (1957) examined the changes in weight and height of English primary schoolchildren from 1911 to 1953 and found a clear upward trend in both with an acceleration since 1945. Between 1945 and 1953 the average gain in weight of boys aged 5 years in urban schools was 4·6 lb. and in county schools 2·6 lb. In London the gain was 6·3 lb. Gains of the same order were found for girls.

The increases in physique which have taken place have obviously outmoded standards of normal weight based on data collected well in the past. The purpose of the present survey was to collect data from which to prepare new standards based on up-to-date figures.

THE SAMPLE

The survey was made in eleven localities of England and Wales:—Birmingham, Bristol, Cardiff, Kent, Leeds, Liverpool, London, Northumberland, Middlesex (Finchley), Norwich and Glamorgan (Rhondda). These localities are widely scattered throughout the country and include both urban and rural areas. The number of children enrolling in the survey in each locality is shown in Table I. The total number was 19,616.

The survey was conducted through welfare centres in the selected localities. These centres were chosen to ensure that babies living under a wide variety of environmental conditions were brought into the survey. Once the survey began in a welfare centre, all babies under two months of age who attended that centre for the first time were, provided the mother was willing, enrolled in the survey. At that stage there was no selection of babies on grounds of health or any other reason. In each locality children continued to be enrolled until the required number had been reached. Special efforts were made to enlist the co-operation of the mothers when they brought their babies to the welfare centre for the first time. The object of the survey was fully explained to them and they were given a letter from the Medical Officer of Health, asking for their co-operation.

The intention was that the survey should continue for at least three years and that during that time information should regularly be collected relating to those babies who had enrolled. The mothers were encouraged to bring their babies regularly and frequently to the welfare centres. The aim during the first year was for the mothers to attend every four weeks; during the second year at least every two months; and during the third year at least every three months. These targets took account of the importance of frequent attendance during early infancy as well as the difficulty of getting mothers to attend after the baby had reached the age of 1 year.

Before each visit of the mother to the welfare centre was due, a letter was sent to her reminding her that this was so. If she failed to attend a health visitor called on her at home, to persuade her to take the baby to the welfare centre at the earliest opportunity. A baby was considered to have defaulted from the survey if during the first year he or she did not attend over a period of eight weeks and during the second year over a period of about six months. For the third year the child was considered to have defaulted only when it was certain that the mother had given up attending the welfare centre. The number of infants who defaulted was higher than was expected. This was fully appreciated during the course of the survey, as counts of the number of defaulters were regularly made. The attention of the staffs of the welfare centres was directed to this on several occasions, in the hope that attendance could be improved. The analyses which were made of the reasons for default showed that in the main the mother just failed to attend, or did not attend because of illness at home or other domestic difficulties or inconveniences.

Period of the survey. The survey started in all areas between the middle of 1949 and the middle of 1950. In all areas some months elapsed before the required numbers had been enrolled.

From the outset the public health departments and the staffs of the welfare centres in the survey co-operated to the full. Most of the work of the survey fell on the doctors and health visitors at the welfare centres and we wish particularly to acknowledge their support and interest, especially as the survey involved them in much additional work.

INFORMATION COLLECTED

Separate record cards were used for recording the data collected during the first, second, and third years of the survey. Another card was used for recording those collected during the fourth and fifth years; this additional information is not analysed in the present report.

When the infant first attended the welfare centre and was enrolled into the survey its sex, birth weight, and place of birth, were recorded, together with the actual and the expected dates of birth (obtained from clinic records or failing that the mother herself), the birth order (counting both previous livebirths and stillbirths), and its medical and feeding history since birth. The birth weight was obtained from the most reliable source. If the baby was born in hospital it was obtained from there; if born at home, from the doctor or midwife. Only if information was not forthcoming from a more reliable source, was it asked of the mother. The ages of the mother and father were also recorded. Generally, the infant was then seen by the doctor.

Each time the child was brought to the welfare centre its weight (nude) was entered on the record card, together with details of its feeding and its clinical condition. The weighing machines, generally the beam type, were checked regularly. Notes were also made on the clinical history since the last time the child attended the centre. Once each year an assessment was made by the health visitor of the general care of the child: at the end of each year the doctor at the welfare centre made a medical summary of the infant's condition based on the clinical history since birth.

During the course of the survey information was collected on the father's, and if she was working the mother's, occupation, the number of adults and children in the child's household, the number of rooms occupied by them, and the mother's education. Records were also made as to whether the child had been immunised against diphtheria and whooping cough. The heights of the infants were also taken first at the age of 18 months and thereafter at six-monthly intervals, except in Bristol and Leeds where the length at birth was recorded.* The information on height is not analysed in the present report.

The coding of the fathers' occupations into social class and the coding of illnesses experienced by the children was kindly done by the General Register Office.

The form of the data. It will be clear from what has already been said that the birth weight was recorded for all the infants who entered the survey, and subsequently weights were taken each time the infants attended the welfare centres. Different children attended different numbers of times and at different intervals over different periods. The survey was thus largely longitudinal, in that an attempt was made to follow through the same children. Tanner (1955) has described such studies as " mixed longitudinal ".

He points out that although data from mixed longitudinal studies have a great importance, their usefulness is less than that of precise longitudinal data, because the number of children measured at certain defined ages over a specific period is in Tanner's (1955) words, likely to be " distressingly small ". It is not practicable from the present data, indeed from the data of any mixed longitudinal study, to make a number of analyses which could readily be made from precise longitudinal data. For some purposes therefore, the present data have been treated as cross-sectional, and for others as longitudinal. The cross-sectional form of analysis has been used in many cases to infer growth, in preference to using smaller samples which would show it directly.

RESULTS

Representativeness of the sample. As the basis for inclusion in the survey was attendance of the infants at the clinic within two months of birth, it is not to be expected that the children in the survey will be a representative national sample of all children born at the time of the survey. That there is a discrepancy is borne out by the fact that the survey included a greater proportion of children from social class III (skilled) families while there was a real deficit compared with the national figures of children from social classes I and II (professional and managerial). The survey included a higher proportion of first-born babies. There was also a slight but unimportant difference as regards the ages of the mothers.

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* A special study was made by Hammond (1955) of the Leeds infants in which he took a series of body measurements when the children were 1 year of age and then at yearly intervals up to the age of 5 years.

The survey children may well not be representative in another way, namely, that the mothers were a rather special group in that they were prepared to attend a clinic and avail themselves of the guidance provided there. The babies may consequently have received better-than-average care, but we have no means of knowing.

That children selected through welfare centres in a few localities would not be a representative national sample was recognised when that particular method of survey was adopted. But any unrepresentativeness of the sample does not detract from its value, as the object of the survey was to obtain standards of weight based on the records of healthy babies as determined by clinical history and medical assessment.

Selection of normal healthy children. Much of the analysis relates to normal children with a satisfactory health record although in examining the association between weight and aspects of the environment, the data of all or a sample of, the children were used. A child was not included in this normal healthy group (*a*) if he or she was one of a multiple birth, or had a birth injury, a persisting congenital abnormality, or an illness of importance before entering the survey: or (*b*) if he or she had important or frequent illnesses, or emotional disturbances as shown by the medical summaries at the end of the first, second, or third year of the survey. Children with a birth weight of 5½ lb. or less were not excluded unless they came within the above categories.

Of the 19,616 children entering the survey, 2,308, that is almost 12 per cent., were excluded from the normal healthy group. The reasons for exclusion were:

Multiple births	92
Birth injury or persisting congenital abnormality, or illness before entering the survey	712
On the basis of the medical summaries	1,504
	2,308

For those children excluded for conditions shown in the medical summaries, the main reasons for exclusion were repeated minor ailments and the fact that in the opinion of the clinic doctor the child had not been physically and mentally healthy and normal since birth. The main part of the analysis is thus based on the data for 17,308 children with a satisfactory health record.

Slightly more of the excluded children than of the whole sample belonged to families of social classes I, II, and III (professional, managerial and skilled) and to the more crowded families. They also had a higher proportion of older mothers. The proportions of excluded children varied in the different localities between 5 per cent. and just over 16 per cent. The grounds for exclusion allowed a good deal of latitude in the clinical assessment and this probably accounts for these differences between localities.

Weight at six-monthly intervals. In view of the large mass of data and the many comparisons which were made in the course of the analysis, some relatively simple method of assessing the relationship between weight and the various biological and social factors had to be used. Such assessments were in the main made from the weights at six-monthly intervals from birth, that is, at 6 months, 1 year, 1½ years, 2 years, 2½ years, and 3 years. These are referred to in the report as " key ages ". In some cases, data for single weeks corresponding to the key ages, e.g. the 26th, 104th, and so on were used; in others, data for the three weeks around the key age were used, e.g. the 25th, 26th, and 27th; the 103rd, 104th, 105th, and so on to provide sufficient numbers in the groups sorted by different criteria.*

(1) *Survivors and defaulters;* (2) *differences between localities.* Two major aspects of the analysis of the data had to be settled at an early stage:

(1) whether the weight of those infants who continued in the survey and of those who defaulted during its course were sufficiently alike to allow the data of the two groups to be combined for purposes of analysis and (2), whether the weights of children in the different localities were sufficiently similar to allow the data for all localities to be combined and treated as one group, instead of requiring separate regional standards.

As regards (1), over the sample as a whole the proportion of defaulters was 42 per cent. by the end of one year, 65 per cent. by the end of two years, and 79 per cent. by the end of three years. The proportion of defaulters varied considerably between localities, ranging at the end of one year from 26 per cent. in one locality to 74 per cent. in another. At the end of three years the proportion ranged from 64 per cent. to 100 per cent.

The average attained weights at the key ages of children who remained in the survey, grouped according to social class and birth order, were compared with those of children who defaulted, the figures for the two largest groups (social class III and first-born children) being shown in Table II. No consistent differences were found which warranted the data for the survivors and defaulters being treated separately. Hence at all later stages of this report the data for both survivors and defaulters have been combined.

In comparing localities, the method was first to ascertain whether there were any differences in the proportions of children as regards social class, birth order, and mother's age. The make-up of the sample was much, although of course not precisely, the same in each locality. The Liverpool sample, for instance, included a larger proportion of children from families of social class V (unskilled), and also of later born (higher birth rank) children than did other localities.

The differences in weight between the areas were relatively small and inconsistent, no regular pattern emerging. As an example, the average weight of girls at one year of age ranged in 10 of the 11 areas between 21·1 lb. and 21·7 lb. the exception being 22·0 lb. For boys the average weight ranged from 22·2 lb. to 23·3 lb. The results did not warrant each locality or any particular group of localities being treated separately in the analysis of the data, which indicates that the same weight standards can reasonably be used throughout the country as a whole.

Birth weight. The average birth weight of the boys was 7·53 lb. and that of the girls 7·21 lb. The standard deviations were 1·18 lb. and 1·13 lb. respectively. The proportions of births of different weights are shown in Table III. About 82 per cent. of both boys and girls had a birth weight of 6 to 8 lb. 4·1 per cent. of the boys and 5·9 per cent. of the girls, giving overall 5 per cent., had a birth weight of 5½ lb. or less.

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* The mean values are not affected and the increase in the variances is negligible.

The birth weights grouped according to sex, birth order, and social class, are shown in Table IV. It is clear that both for boys and girls the birth weight rose from first born to later born children and at least for girls, and possibly also for boys, it fell from the professional and managerial to the unskilled classes. The difference between the average birth weight of first-born children and second born children was about 0·2 lb., and that between second and third born children between 0·1 and 0·15 lb. Between third and later born children there seemed to be no difference. Differences between the birth weights in the various social classes were clearcut but small; between social class I (professional) and social class V (unskilled) the difference was less than 0·2 lb. The figures in the body of Table IV show that these trends were present for the individual social classes and the individual birth orders.

Despite the smallness of these differences in average birth weight, the proportion of children with very low or very high birth weights varied widely according to social class and birth order. Table Va shows that the proportion of boys with a low birth weight increased from the professional and managerial to the semi-skilled and unskilled classes; Table Vb shows an increasing proportion of babies of high birth weight with increasing birth order. The greatest proportion of babies of low birth weight was among the first-born babies of the less skilled classes and the lowest proportion among the later born babies of the professional and managerial classes. The reverse is the case for heavy babies. Thus about 7 per cent. of first-born boys in the less skilled classes weighed 9 lb. or more at birth; the corresponding figure for fourth or later born babies of the professional and managerial classes being 20 per cent. or more.

The average birth weights showed no consistent trend according to the month of birth. A sample of birth weights showed that children born at home weighed on average about ¼ lb. more than did those born in hospital and that the birth weight also increased with the duration of gestation even after full term as measured by the difference between the actual and the expected date of delivery (Table VI). No differences were found according to the age of the mother.

Attained weight up to the age of 3 years. Table VII gives the average weights of normal healthy boys and girls and their standard deviations (calculated in the normal way) at four-weekly intervals from birth to 3 years. A smoothed curve of attained weight and also of growth since birth based on data for each week of age is given separately for boys and girls in Figures I*a* and *b*.

Four phases of growth can be distinguished:

(*a*) relatively variable growth for the first four weeks. During this time some children have only just made up the initial loss they have sustained;

(*b*) a rapid increase to age 16 weeks by which time boys average about 14½ lb. and girls about 13¾ lb. in weight. The difference between the weights at birth of boys and girls of about one-third of a pound has by that age increased by a further 1 lb. The rate of growth over this period averages about ½ lb. a week;

(*c*) a gradual slight decrease in the rate of growth up to about 16 months; the attained weights at 12 months are about 23 lb. for boys and 21½ lb. for girls;

(*d*) a fairly uniform growth rate thereafter until 3 years, at which age boys on average reach a weight of about 32½ lb. and girls a weight of about 31½ lb.

The birth weight of girls was on average less than that of boys and in the early weeks of life they also grew more slowly than did boys; the average weight of girls is thus less than that of boys of the same age up to at least the age of 3.

Although the scatter of the attained weights at various ages is indicated in Table VII, by the standard deviation, it is recognized that the attained weights are not normally distributed but are positively skew. Table VIII therefore gives the 1st, 5th, 20th, 50th, 80th, 95th and 99th percentiles,* of the weight distribution at six-monthly intervals.

The association between growth and various factors

(*a*) *Birth weight.* Smoothed curves of attained weight from birth to 3 years of boys and girls, grouped according to birth weight, are shown in Figure II*a* and *b*. Although all the available data have been used in constructing these curves, the numbers at the later ages are small and hence the curves at these ages are rather tentative. But the curves are clearly separated throughout the whole period. Over the three years, the gain in weight of boys exceeded that of girls of the same birth weight; the maximum difference between the curves of about 1½ lb. occurs at about the age of 1½ years.

The pattern of growth from birth to 3 years was not however the same for each birth weight group as can be seen from Figure III which shows smoothed curves of increases in weight, that is of the velocity of growth. From birth to about the age of 6 months babies smaller at birth grow faster than do those larger at birth but then a change-over occurred and the rate of growth of the larger babies exceeds that of the smaller babies. By the age of 3 years, the total growth from birth of the larger born babies slightly exceeded that of the smaller born babies.

(*b*) *Duration of gestation.* It was stated above that babies born early (as measured by the difference between the actual and the expected dates of delivery) were on average smaller at birth than those born late. In view of the relationship between birth weight and subsequent weight gain it is to be expected that children born early will have a greater weight gain at least during the first year than those born late. This was in fact so.

(*c*) *Birth order.* The gains in weight since birth of healthy normal children of different birth order, and belonging to social class III (skilled), are given in Table IX. Up to the age of 3 years, the gain in weight fell with increasing birth order. This was mainly due to a greater gain in the first year by the babies of low birth rank.

(*d*) *Feeding.* Comparison was made of the gain in weight during the first year between matched groups of single born infants one of which had never been breast-fed or who had been taken off the breast before the third week of life and the other groups who were still fully breast-fed at the age of 15, 16 or 17 weeks. The comparison was made for boys of birth weight of 7 to 8 lb., of social class III (skilled) families whose mothers were aged between 20 to 40 years and whose care had been satisfactory. The samples were matched for locality and comparisons were made separately for first-born and later born children. Thus in all, the samples were matched by seven factors, which reduced the numbers in the groups.† The gains in weight since birth of the various groups at 3, 6, 9 and 12 months are shown in Table X.

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* If 100 children are arranged in order of increasing weight then the weight of the 5th child will represent the 5th percentile, of the 20th child, the 20th percentile, and so on.

† A random sampling technique was adopted to ensure comparability.

Although the samples are small it is clear that the bottle-fed infants gained substantially more weight during the first year than did the breast-fed infants.

(*e*) *Season of the year*. Examination of the weight gains up to the age of 3 months of children born in different months of the year, shows that gains were most for those born in about April to July and least for those born in about November to January. The difference in growth was rather less than ½ lb. for girls and about ¾ lb. for boys.

Table XI shows the gain in weight of boys and girls born in the months of January, April, July and October, over three-monthly intervals from birth to the age of 3 years. This not only demonstrates the pattern of growth of infants but also enables comparison to be made between the seasonality of growth of infants and of schoolchildren (Bransby 1945*a*, *b*).

During the first year of life growth was greatest in the summer, that is in the quarters April to June and July to September, growth in July to September tending to be somewhat greater than that in April to June. As age increased, so growth in July to September continued well above the average but that in April to June decreased substantially and no longer occupied the second position as was the case during the first year. Indeed, during the third year growth in April to June was less than in any other quarter and the pattern of growth was tending to be much the same as for older children. For them, the least seasonal increment almost invariably occurred in April to June, and the greatest in July to September. Hence, not only was there a marked seasonality of growth in infancy, but the pattern changed with age.

There is also probably a change in the intensity of the fluctuations in growth from one part of the year to another. This can be illustrated by comparing growth over the first 3 months of life with that over the 3 months from 2 years 9 months to 3 years. In the first period the proportion of the yearly growth gained in each quarter ranged from about 24 per cent. to about 27 per cent. Had growth been equal in all four quarters the gain in each would have been 25 per cent. In the latter period however the range was from 12 per cent. in the lowest quarter to 37 per cent. in the highest.

The intensity of the fluctuations was of course affected by the smaller numbers at the later ages and by the greater variability in quarterly growth between individual children at later compared to earlier ages, which is referred to on page 10. But there is no doubt that the seasonal pattern and its intensity in early infancy is very different from that in later childhood; the figures in Table XI suggest that the change is already in progress before the age of 3 years. A similar analysis of other data would be of interest.

Bransby (1945*a*, *b*) and Spies (1948) have both expressed the opinion that short term fluctuations in growth are indications of inadequate growth and health status. It is interesting that the present data show that at least on average the growth of infants is comparatively steady during the early months of life, that is during the time they are largely protected from the environment, but later the fluctuations become increasingly marked.

(*f*) *Social class*. Table XII shows the gains in weight since birth of infants of the different social classes. Distinction is made between first-born and later born children. The Table is based on the data of both the normal healthy children and the excluded children.

Up to the age of 6 months there was no consistent trend with social class, but as the following Table, which is based on Table XII, shows, between the ages of 6 months and 1 year the weight gains fell from the professional class to the unskilled class.

Social Class	First-born babies		Later born babies	
	Boys	Girls	Boys	Girls
	lb.	lb.	lb.	lb.
I and II—(Professional and managerial) ...	5·8	5·4	5·1	5·1
III—(Skilled)	5·3	4·9	5·1	4·8
IV—(Semi-skilled)	4·9	4·9	5·0	4·2
V—(Unskilled)	5·1	4·6	4·9	4·7

After the age of 1 year, differences in growth rates cannot consistently be detected.

(*g*) *Other factors.* No difference in the rate of growth could be detected associated with the character of the birth, the mother's education, overcrowding, and whether or not the child slept in a separate room. Nor were there differences in the weight gain of children whose care was judged to be adequate compared to that of those whose care was judged to be excellent. In a few cases the care of the child was recorded as poor and these children, so far as could be assessed from the few data available, were lighter by about 1 to 2 lb. from about the age of 1½ years onwards.

A finding of interest is that no consistent differences in attained weights or gains in weights were detected between the normal healthy children and the excluded children. Another group was distinguished—a really healthy group, namely, where there had been no illness of any kind other than very minor. Here again no differences were found between that and the normal healthy group.

Gain in weight over four-week periods. The mothers were encouraged to bring their babies during the early stages of the survey to the welfare centres at four-weekly intervals, and many did so. The records which thus became available have been used for an analysis of four-weekly weight gains. Comparison of the curves of attained weight from birth to 3 years of these normal healthy children with those of all the normal healthy children in the survey revealed no difference between them. Hence the former can be considered a representative group of the latter. The main purpose of this analysis was to consider the relationship between the actual four-weekly weight gains and their variations as measured by their standard deviations.

The standard deviation of the four-weekly weight gains fell from about 0·8 lb. at 4 weeks of age to about 0·5 lb. at 1 year, and remained at about that level up to the age of 3 years. Up to the age of 6 months the four-weekly gain in weight averaged rather less than 2 lb., and from 6 to 12 months less than 1 lb. Thereafter up to the age of 3 years, it averaged less than ½ lb. Hence, up to the age of 6 months the average weight gain was two to three times its standard deviation and from then up to the age of 1 year about twice its standard deviation. After that the weight gain was about equal to the standard deviation.

These data indicate that up to the age of 6 months it is rare for a normal healthy child to fail to gain weight in any four-week period. After that, failure to gain weight over any four-week period can be expected fairly frequently as part of the normal fluctuation in growth. The relevant data show that of the normal healthy children measured at intervals of four weeks between the ages of 1 month and 6 months, 0·6 per cent. lost weight between one weighing and the next. Between the ages of 6 and 9 months the proportion was about 3 per cent. and between 9 and 12 months, about 10 per cent. Repeated failure to gain weight in an individual child cannot however be considered as part of the normal fluctuation in growth; failure to gain in more than one four-weekly period, even if separated by an interval of time, can be considered as unusual.

Gain in weight over three month periods. The weights of all normal healthy children who were measured at birth and at the age of 13 weeks; at the ages of 13 and 26 weeks; at the ages of 26 and 39 weeks, and so on, up to the age of 3 years were examined. The average gains in weight of these samples of children in the three-monthly intervals, with their standard deviations, are given in Table XIII.

Up to the age of 6 months the average quarterly gain in weight was three to four times its standard deviation. From 6 to 9 months it was two to three times, and from 9 to 12 months about twice its standard deviation. In the second year the average three-monthly gain was about one and a half to two times, and in the third year about one and a half times its standard deviation.

These figures show that up to the age of 6 months it is very rare for children to fail to gain weight over an interval of 3 months and it is rare (about twice in 100) to do so up to the age of 9 months. From the age of 1 year onwards such failures may occur fairly frequently (about 7 times in 100).

RESULTS OF OTHER ENQUIRIES

Studies have been made of weight in infancy and its association with biological and social factors by a number of workers. The findings from some of these studies are given below.

Average birth weight. The average birth weights found in the present survey, 7·53 lb. for boys and 7·21 lb. for girls, are close to those found in other enquiries. Thus, the mean birth weight for all live births in Birmingham in 1947 was 7·46 lb. (McKeown and Gibson, 1951); that in the Borough of Heston and Isleworth in 1945–49 was 7·5 lb. for boys and 7·2 lb. for girls (Anderson, 1953).

" *Prematurity* ". Five per cent. of the infants in the present survey had a birth weight of 5½ lb. or less, that percentage being low compared with 6·4 per cent. of the single live births recorded in " Maternity in Great Britain " (1948), and with 6·2 per cent. of over 700,000 notified live births in 1951 (Ministry of Health, 1950).

The low proportion of " premature " infants in the present survey is due to the exclusion of small babies born in hospital who did not come at an early age to the welfare centres.

Birth weight and biological factors. Data from various surveys (McKeown and Gibson (1951); Hewitt and Stewart (1952); Anderson (1953)) show, as did those from the present survey, that birth weight increases with increasing birth order.

There is also an increase with duration of gestation (Gibson and McKeown (1951); Karn and Pearson (1951)).

Birth weight and social conditions. Studies in addition to the present indicate an association between birth weight and social conditions. Gibson and McKeown (1951) found that in Birmingham the birth weight was slightly but significantly lower in the poorest group as judged by the standard of housing than in the group with better living conditions; Hewitt and Stewart (1952) found a significant inter-class difference, this being reduced when allowance was made for parental size, and Anderson (1953) found that among domiciliary births the birth weight was less where the midwife's services were free or charged at a reduced fee than where the full fee was charged.

Weight up to the age of 3 years. Table XIV, which calls for no detailed comment, shows the attained weights up to the age of 3 years found in other enquiries. All that need be said is that the average attained weights found in the present survey are much in line with those reported from other recent surveys.

Gain in weight after birth: association with birth weight. Illingworth (1939) found that children who weighed 5½ lb. or less at birth were lighter throughout childhood than those who weighed 8½ lb. or more. Later work confirmed that the average weight throughout childhood is greater, the greater the birth weight (Asher (1946); Drillien (1948); Illingworth, Harvey and Gin (1949); Norval, Kennedy and Berkson (1951); Anderson (1953)).

From a special study of growth in the first year of life, Parfit (1951) concluded that growth between the ages of 1 month and 1 year tended on average to be the same for all babies of the same sex, irrespective of birth weight. Other workers came to much the same conclusion (Hammond (1952); Simpson (1953); Thomson (1955*a*); Hahn (1955)). Lowe and Gibson (1953) found that gain in weight by the third birthday was independent of birth weight. In a study of premature children, Douglas and Mogford (1953) observed that compared with normal children, they did not reduce their weight handicap between birth and the age of 4 years; they were less retarded in weight at 2 years than at birth, but they lost ground between the ages of 2 and 4.

Herdan (1954) took the view that complete independence of birth weight and subsequent weight gain, as suggested by some other workers, was an over-simplification, as his data showed that at 13 and 26 weeks of age, children who weighed up to 7 lb. at birth had gained more weight than had those who weighed more than 7 lb. at birth. He suggested that whatever it may be, the relationship between birth weight and subsequent weight gain probably changes with age.

The findings from the present survey confirm Herdan's opinion. Gain in weight after birth appears to be largely but not entirely independent of birth weight, the relationship changing with age.

Gain in weight after birth: association with birth order. Ewart (1912) found that at the age of 6 months, first-born children were heavier than later born children by about 1½ lb., and McKinlay (1926) found that whereas weight at 1 month was greater the greater the birth order, the reverse was the case at 1 year. The findings from a number of other studies (Hammond (1952); Hewitt and Stewart (1952); Lowe and Gibson (1953); Cawley, McKeown and Record (1954); Douglas and Blomfield (1958)), as did those from the present survey, confirm that on average earlier born babies soon compensate for their lower birth weight and within a short time are heavier than later born babies.

Gain in weight after birth: association with feeding. Results from four other studies are available on the association between weight gain during the first year and the method of infant feeding. Simpson (1952) found that infants breast-fed for less than two months gained 9–10 ounces more in the year than those who were breast-fed for longer. Two papers based on data from the Oxford Child Health Survey show that the weight gain during the first year of infants where breast-feeding was never fully established, was almost 1 lb. more than those of infants where breast-feeding continued for longer than 5 months (Hewitt and Stewart (1952); Stewart and Westropp (1953)). Thomson (1955*a*) found no difference in the weight gain at 16 weeks of matched pairs of female singleton first-born infants, one infant being breast-fed, the other bottle-fed. The present survey shows little difference between the weights of breast and bottle-fed babies in the early months, but later the bottle-fed babies are heavier.

Gain in weight after birth: association with social factors. Gore and Palmer (1949) found no weight differentiation between children in different boroughs in London up to the age of 18 months, but from then up to the age of 5 years, consistent but not statistically significant differences. Hammond (1952) observed no consistent differences up to the age of 1 year between the weight gains of children of the various social classes.

Hewitt and Stewart (1952) found that at the end of twelve months it was no longer possible to show any social gradient of weight when allowance was made for parental size. They say there are two reasons for this, that parents of social classes I and II (professional and managerial) are bigger than those of the other social classes and babies of the working classes are more often bottle-fed than those of the professional and managerial classes. It is, however, apposite that Douglas and Blomfield (1958) found that allowance for differences in maternal height reduced only to a slight extent social class differences in height at the age of about 4 years.

STANDARDS OF NORMAL WEIGHT

In discussing the influence of social and genetic factors on infant weight, Hewitt and Stewart (1952) say: " The assessments of weight in infancy must always be made by reference to some standard weight or range of weights which is thought to be normal for healthy babies of a given age ". They make the point that the value of such standards will be improved by allowing in them for inherent factors which themselves influence growth. Thus, since the rates of growth in infancy differ for boys and girls, there should be separate standards for boys and girls in preference to one standard common to both. Consideration of standards of weight thus involves a search for biological as distinct from environmental factors which, when introduced into standards of normal weight, reduce the allowable range of normal variability and so enable smaller deviations from the average to be detected as abnormal. Distinction is made between biological and environmental factors because the former are inherent, while one of the main objects of child welfare work is to correct any adverse effects of the latter on health.

In commenting on the results from their study, Hewitt and Stewart (1952) direct attention to the difficulty of assessing the relationship between infant growth and individual aspects of the environment:

> " Yet in spite of these refinements it is impossible to draw any precise conclusions about the influence of the environmental factors which have been

studied. The difficulty was due . . . . . . to a failure to obtain for each group of babies defined by parental size, the same cross-section of environmental conditions. Such failure is almost inevitable in social as distinct from laboratory experiments, and in fact most of the effects selected for study were inextricably confounded: ante-natal health with parity; maternal efficiency, household amenities and sickness with parental size; and social class with feeding habits."

In social investigations including studies of growth, experimental conditions cannot be re-arranged to suit the investigators' requirements; conditions have to be examined as they are. It is seldom possible to be sure that in considering the association between any pair of factors, only those particular factors are involved.

Biological factors which appear from this and other studies certainly to influence gain in weight after birth are:

(1) *Sex.* Up to the age of 3 years, and indeed up to the puberty spurt in girls, boys are heavier than girls.

(2) *Birth weight.* Weight gain after birth is largely, but not entirely, independent of weight at birth. In the first few months smaller babies grow more rapidly than do larger babies, but later the trends are reversed. At the age of 6 months the gain in weight from birth is about ¼ lb. less for every 1 lb. increase in birth weight. Approximately the same difference remains at the age of 1 year.

(3) *Birth order.* Birth weight increases slightly with increasing birth order; weight gain after birth, however, goes in the opposite direction. At the age of 1 year, the weight of first-born infants exceeds that of later born infants by about ½ to 1 lb.

(4) *Parental size.* Studies by Douglas and Mogford (1953) and Hewitt and Stewart (1952) show an association between parental stature and the weight of the infant.

(5) *Season of the year.* There is a marked seasonality of growth, the pattern and intensity of which varies with the age of the child. It is questionable whether this can be considered a biological factor, as it may well be associated with the environment.

Environmental factors associated with growth are:

(1) *Feeding.* The gain in weight of bottle-fed infants is greater than that of of breast-fed infants.*

(2) *Social class.* Before account is taken of parental size, growth is greater in the professional and managerial classes than in the unskilled classes, but Hewitt and Stewart (1952) found that when such an allowance was made, no social gradient could be demonstrated at the age of 12 months. However, Douglas and Blomfield (1958) found a social gradient in height at the age of 4¼ years.

Other factors, for example maternal efficiency, home amenities, sickness experience, may also be associated with differences in gains in weight.

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* This does not mean that bottle feeding is preferable to breast feeding as factors other than gain in weight must be considered. In addition, the babies who were bottle-fed may have been "selected" for various reasons.

An improvement in the efficacy of standards of normal weight would probably result by allowing for all the above biological factors but that is hardly practicable. In practice we have to decide for which, if any, allowance should be made. Most workers in this field recommend separate standards for boys and girls. Hewitt and Stewart (1952) also recommend allowance for birth order and parental size. Many workers have also expressed the opinion that as gain in weight over the first year is independent, or largely independent, of birth weight then standards of gain in weight are preferable to standards of attained weight.

Obviously, there is an advantage in having separate standards for boys and girls. On the other hand it is not practicable to have different standards for children born at different times of the year, especially in view of the change in seasonal pattern with age. Nor is it practicable to base norms of growth on parental size, which it is difficult to get in day-to-day work, for example, in infant welfare centres. The size of a child's parents might, however, be taken subjectively into account in assessing his or her progress.*

The next point is whether allowance should be made for birth order—the question is really whether the differences in growth associated with birth order are sufficient to warrant separate standards for the different parities. No practicable difficulty would arise in this, but considering the great variation in growth and the relatively small improvement in precision which would result, allowance hardly seems worth while. Any such allowance might well give a false impression of the accuracy of the standards.

Another point of importance is that opinion is divided as to whether or not differences of growth associated with birth order are " due to biological superiority or better environment " (Douglas and Blomfield (1958)). Hewitt and Stewart (1954) in recommending that allowance should be made for birth order in standards of normal weight, obviously believe differences arise from biological superiority. On the other hand, Douglas and Blomfield (1958) accept that the probable explanation is better environment. On balance allowance for birth order in standards of normal weight does not seem to be justified.

The main question which remains to be decided is thus, whether standards should relate to gain in weight or to attained weight. A point of importance here is that gain in weight is not entirely independent of birth weight, although the association between the two is small and not sufficient to warrant separate growth standards for different birth weight groups.

Which of gain in weight or attained weight is preferable depends on the precision with which each can detect abnormalities in growth. It would at first appear that a very real advantage would lie with standards of gain in weight, as differences in birth weight no longer confuse the picture. But the available evidence indicates that the advantage is less than might be expected, at least for the very large majority of babies whose birth weight is not too far removed from the average.

The main evidence comes from comparison between the variability at corresponding ages, as measured by the standard deviations, of attained weight and gain in weight. The data derived from the present study for various ages in the first year together with data from Parfit's (1951) study of 662 babies in Oxford up to the age of 1 year, are given in Table XV. Data from the present survey show that at least from the age of 3 months, and probably earlier, there is little difference between the two sets of standard deviations. Naturally the difference becomes greater the nearer to birth, but even at the age of 6 weeks it is not marked. The two sets of standard deviations derived from Parfit's (1951) study are very close indeed, the greatest difference between them at any age being 2 oz.

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* During the course of the present Survey a special study was made, based on data relating to the survey infants in Leeds, of the relationship between the parents' height, weight and physical type and the child's growth during infancy. In general it was found that during the first year the effects of these factors were slight but that they increased as the infant became older. The results indicate that at least in early infancy there is no real reason for making allowance for these factors in standards of weight.

What these small differences between the variabilities of attained weight and gain in weight mean can be illustrated by the figures found in the present survey for boys aged 13 weeks. The standard deviation of their attained weights is 1·64 lb. and that of their gain in weight, 1·38 lb. If the normal range of variation is taken as ±2 standard deviations then the range is about 6½ lb. for attained weight and 5½ lb. for gain in weight. At 6 months the corresponding figures are about 8¼ lb. and 7¼ lb. and at 1 year, 10 lb. and 9¼ lb. Parfit's (1951) data give ranges of 6 lb. and 5¾ lb. respectively at 3 months.

The unexpectedly small differences between the standard deviations of attained weight and gain in weight are due in the first place to the great bulk of the birth weights being clustered in a relatively narrow range, and, secondly, to the fact that small babies grow more quickly in the early months than do larger babies, thus reducing the differences in attained weight due to differences in birth weight. But although the differences are on average reduced, they are not eliminated. Thus at the age of 1 year infants who differ on average by say 4 lb. at birth still differ by about 3 lb. on average at the age of 1 year.

The position then is that it would seem that there is some advantage, particularly in the early months of life, in using standards of gain in weight in preference to standards of attained weight. But considering the influence of other factors such as seasonality, birth order and parental size, which obviously limit the precision of any standard, it is doubtful if the advantage in using standards of growth is really of practical importance to those of average or near average birth weight. For those children whose birth weight is markedly different from the average, this fact might be taken into account, and for them it might be better to use standards of growth in preference to standards of attained weight.

In setting limits for the range of normal variation, the customary allowance is ±2 standard deviations. In regard to attained weight however, because of its skew distribution it is better to base the limits on percentiles than on standard deviations. If the 5th and 95th percentiles are taken, this allows for 1 in 10 of normal healthy children to fall outside what might be called the " warning limits ". The same limits might be taken for gain in weight. Figure 1 gives these normal ranges for both attained weight and gain in weight and it is suggested that these should be used as standards.

It is recognised that the curves of normal attained weight and gain in weight are derived from data of normal children with a satisfactory health record. It might be argued that the full variation found in the survey should be the basis for setting the limits of permissible variation. But this assumes that the normal healthy children did not experience any short-term temporary setbacks in growth due to minor illnesses and the like. In any case there is nothing to be lost in setting somewhat narrower " warning limits ".

In considering standards of normal weight in infancy distinction is usually drawn between standards for children up to the age of 1 year and those for children over the age of 1. Such a distinction is reasonable as gain in weight is much greater in early than in later infancy and that in early infancy represents a major aspect of general development. A young infant's progress in weight is recognised as a valuable guide to its general health. Of course progress in weight in early childhood is also important, but the average gain in weight compared with its variability is much less than it is in infancy. Thus in the second and third year of life, losses in weight can fairly frequently be expected over intervals of 1 month or a good deal longer, as part of the normal fluctuation of growth, even among children with a satisfactory health record.

Table XVI sets out the lower limits which might be used as a practical guide to unsatisfactory weight progress. The large normal variation in the growth of infants means that standards of normal attained weight, or weight gain or indeed of any other aspect of growth, cannot be interpreted rigidly. At most, these can serve only as one piece of evidence in the overall clinical picture in arriving at an assessment of the health of the infant.

SUMMARY

(1) A survey was made in eleven localities in England and Wales to collect data from which to prepare up-to-date standards of normal weight in infancy. The survey started in all areas between the middle of 1949 and the middle of 1950.

(2) The survey was conducted through welfare centres in the selected localities. Once the survey was begun in a centre all babies who attended for the first time under the age of 2 months were, provided the mother was willing, enrolled into the survey. For each child the survey continued until it reached the age of 3 years, or until it defaulted. 19,616 children were enrolled.

(3) During the course of the survey the infants were weighed each time they attended the welfare centre and records were taken of their medical history. A wide range of environmental information was also collected.

(4) The average birth weight was 7·53 lb. for boys and 7·21 lb. for girls. Both for boys and girls the birth weight rose from first-born to later born children and for girls (at least) from the unskilled to the professional and managerial classes. The greatest proportion of low birth weights occurred among the early born children of the unskilled classes and the greatest proportion of high birth weights among the later born children of the professional and managerial classes.

(5) From birth to the age of 3 years, four phases of growth can be distinguished: (i) relatively variable growth for the first 4 weeks; (ii) a rapid increase to age 16 weeks, by which time the boys averaged about 14½ lb. and the girls about 13¾ lb. in weight; (iii) a gradual slight increase in the rate of growth up to about 16 months; attained weights at 12 months were about 23 lb. for boys and 21½ lb. for girls; (iv) a fairly uniform growth rate thereafter until 3 years, at which time boys on average have reach a weight of about 32½ lb. and girls a weight of 31½ lb.

(6) The gain in weight from birth to 3 years was largely but not entirely independent of birth weight. In the first few months smaller babies grew more rapidly than did larger babies but later the trends were reversed.

Gain in weight from birth decreased slightly with increasing birth order. There was a marked seasonality of growth, the pattern and intensity of which changes with increasing age.

Gain in weight after birth was greater for bottle-fed than breast-fed infants and for children of the professional and managerial classes than of the unskilled classes.

(7) The average gain in weight over periods of 4 weeks was, up to the age of 6 months, two to three times its standard deviation, and from then to the age of 1 year about twice its standard deviation. From 1 year until the age of 3 years it was about equal to its standard deviation. Up to the age of 6 months it is thus rare for a normal healthy child to fail to gain weight in any four-week period. After that, failure to gain in a four-week period can be expected with increasing frequency as part of the normal fluctuation in growth.

(8) The average gain in weight over three-month periods up to the age of 6 months was three to four times its standard deviation. From 6 to 9 months it was two to three times, and from 9 to 12 months about twice its standard deviation. In the 2nd and 3rd years it was about one-and-a-half to two times. From the age of 1 year onwards failure to gain weight in a three-month period will thus occur fairly frequently as part of the normal fluctuation in growth.

(9) As regards standards of normal weight, it is suggested that allowance need not be made in the standards for the biological factors of parental size and birth order, despite their slight association with the rate of weight gain after birth, for seasonality, or for any of the environmental factors associated with growth. There should, however, be separate standards for boys and girls.

(10) The evidence indicates that the advantage of basing standards on gain in weight since birth rather than attained weight is less than might at first be expected. Since miscellaneous biological factors will affect the precision of the standards which are adopted it is doubtful whether the small advantage of standards of gain in weight over standards of attained weight is really of practical importance at least for the great majority of children with a birth weight not too far removed from the average.

(11) Standard curves both of attained weights and of gain in weight from birth to the age of 3 years are presented, together with zones of normal variation, defined by the 5th and 95th percentiles.

A table is given setting out the lower limits which might be used as a practical guide to unsatisfactory weight progress.

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TABLE I

Number of infants who entered the Survey

Birmingham	2,046
Bristol	1,067
Cardiff	1,443
Kent	1,818
Leeds	1,859
Liverpool...	2,421
London	3,988
Middlesex (Finchley)	653
Northumberland	2,095
Norwich	1,418
Glamorgan (Rhondda)	808
TOTAL	19,616

TABLE II

Average weights (lb.) of infants who continued in the Survey (Stayers) with those who defaulted (Leavers)

Infants of Social Class III (Skilled)

Age	BOYS		GIRLS	
	Stayers	Leavers	Stayers	Leavers
26 weeks	18·2	17·8	17·0	16·6
52 „	23·1	23·0	21·4	21·7
78 „	25·8	26·2	24·6	24·5
104 „	28·8	28·0	26·7	28·2

First-born Infants

Age	BOYS		GIRLS	
	Stayers	Leavers	Stayers	Leavers
26 weeks	18·2	18·0	16·9	16·6
52 „	23·0	23·1	21·4	21·6
78 „	26·2	26·5	24·5	24·8
104 „	28·7	28·1	26·8	28·5

Note: The weights of "leavers" at 26 weeks relate to those who defaulted after 26 weeks and so on.

TABLE III

Proportion of infants with different birth-weights

Birth Weight	Boys	Girls
	per cent.	per cent.
Under 4 lb.	0·2	0·3
4 lb.	1·1 } 5½ lb. and under =	1·7 } 5½ lb. and under =
5 lb.	6·2 } 4·1 per cent.	8·6 } 5·9 per cent.
6 lb.	21·2	28·7
7 lb.	35·9	36·2
8 lb.	25·0	18·3
9 lb.	8·3	5·2
10 lb. or more ...	2·1	1·0
All weights ...	100·0	100·0

Based on the data of all survey births, before exclusions.

TABLE IV

Birth weight by social class and birth order

Birth Order

Social Class	1		2		3		4 or more		Average	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	All Boys	All Girls
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
I—Professional	7·35	7·22	7·74	7·41	7·95	7·44	8·02	8·01	7·59	7·34
II—Managerial	7·54	7·18	7·66	7·35	7·57	7·46	8·10	7·64	7·62	7·30
III—Skilled	7·38	7·09	7·59	7·30	7·79	7·37	7·66	7·34	7·53	7·21
IV—Semi-skilled	7·33	7·08	7·66	7·17	7·62	7·46	7·75	7·52	7·52	7·21
V—Unskilled	7·30	6·93	7·42	7·25	7·57	7·30	7·75	7·39	7·46	7·15
Average	7·39	7·08	7·59	7·28	7·73	7·38	7·72	7·40	7·53	7·21

Based on the data of all survey births, before exclusions.

TABLE V (a)

Percentage of first-born infants in the different social classes with birth weights of less than 6 lb.

	First-born	
	Boys per cent.	*Girls* per cent.
Social classes I and II (professional and managerial)	*5·9*	*8·9*
Social class III (skilled)	*9·0*	*12·5*
Social classes IV and V (semi-skilled and unskilled)	*9·1*	*13·8*

TABLE V (b)

Percentage of infants of social class III (skilled) and of different birth order with birth weight of 9 lb. or over

Birth Order	*Boys* per cent.	*Girls* per cent.
1	*6·8*	*4·2*
2	*11·1*	*6·2*
3	*16·1*	*9·2*
4 or more	*15·2*	*11·5*

Based on the data of all survey births, before exclusions.

TABLE VI

Birth weight according to whether the baby was born earlier or later than expected

	Boys	Girls
	lb.	lb.
5 weeks early ...	6·30	6·08
4 " " ...	6·79	6·05
3 " " ...	7·04	6·67
2 " " ...	7·24	6·89
Up to 1 week early ...	7·40	7·21
Up to 1 week late ...	7·74	7·35
2 weeks late ...	7·90	7·68
3 " " ...	7·75	7·48
4 " " ...	7·87	7·47

Based on the data of a sample of births, before exclusions.

TABLE VII

*Average attained weights and standard deviations**

from birth to 3 years

	Boys		Girls	
	Attained Weight	Standard Deviation	Attained Weight	Standard Deviation
	lb.	lb.	lb.	lb.
At Birth	7·5	1·2	7·2	1·1
Week 4	8·9	1·1	8·4	1·0
8	10·9	1·5	10·2	1·3
12	12·8	1·7	11·8	1·4
16	14·4	1·9	13·3	1·6
20	16·0	2·0	14·7	1·7
24	17·3	2·1	16·1	1·8
28	18·4	2·2	17·1	1·9
32	19·6	2·2	18·1	2·1
36	20·5	2·3	19·0	2·1
40	21·2	2·3	19·6	2·2
44	21·9	2·4	20·4	2·3
48	22·6	2·5	20·9	2·3
52	23·0	2·5	21·5	2·4
56	23·5	2·6	22·0	2·5
60	24·1	2·6	22·6	2·5
64	24·4	2·7	23·1	2·5
68	25·0	2·7	23·6	2·5
72	25·4	2·7	23·9	2·7
76	25·7	2·7	24·4	2·7
80	26·0	2·7	24·5	2·7
84	26·6	2·7	24·9	2·8
88	26·9	2·7	25·5	2·8
92	27·2	2·8	25·9	3·0
96	27·4	2·8	26·4	2·9
100	27·9	2·7	26·6	3·0
104	28·4	2·8	27·0	3·5
108	28·6	2·9	27·2	3·7
112	29·0	3·2	27·5	3·5
116	29·2	3·1	28·2	3·6
120	29·4	3·4	28·6	3·6
124	29·6	3·5	28·8	3·6
128	30·0	3·6	28·9	3·5
132	30·2	3·6	29·2	3·6
136	30·7	3·7	29·3	3·8
140	31·5	3·6	29·7	4·0
144	32·0	3·5	30·1	3·9
148	32·3	3·5	30·5	3·8
152	32·5	3·6	30·8	3·7
156	32·6	3·5	31·6	4·2

Based on the data of all normal healthy infants weighed in the stated weeks.

* It is recognised that the distribution of attained weights at any age is skew. The standard deviations are nevertheless tabulated as is customary for such data and because some of the argument in the section "Standards of normal weight" is based on a comparison of variability as measured by the standard deviation.

TABLE VIII

Percentiles values of attained weight

Percentiles

Age	Number	1	5	20	50	80	95	99	Mean Weight
		lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
				BOYS					
26 weeks	1,198	13·4	14·7	16·3	17·9	19·6	21·6	23·4	18·0
1 year	1,002	16·1	19·0	21·1	22·9	25·0	27·1	29·1	23·0
1½ years	449	20·3	21·2	23·6	25·8	28·1	31·0	33·1	25·9
2 years	332	22·4	24·0	25·9	28·4	30·6	33·1	36·9	28·4
2½ years	162	20·4	25·6	28·6	30·6	33·5	37·1	38·5	31·0
3 years	209	20·3	27·1	29·3	32·3	36·0	39·4	42·0	32·6
				GIRLS					
26 weeks	1,255	12·6	13·7	15·0	16·7	18·3	19·8	21·3	16·7
1 year	1,006	16·0	17·9	19·6	21·5	23·6	25·6	27·6	21·5
1½ years	473	18·7	20·6	22·3	24·3	26·6	28·7	30·3	24·4
2 years	301	19·4	21·6	24·2	27·3	29·6	32·8	34·5	27·0
2½ years	170	19·3	23·3	26·0	28·9	31·5	34·5	37·3	28·9
3 years	215	24·0	26·0	28·5	31·7	34·5	37·0	39·6	31·6

Based on the data of all normal healthy children weighed at the stated times.

TABLE IX

Gain in weight since birth according to birth order

Social Class III (skilled) only

Birth order	6 months	1 year	1½ years	2 years	2½ years	3 years
	lb.	lb.	lb.	lb.	lb.	lb.
			BOYS			
1	10·5	15·8	18·5	21·3	23·0	25·1
2	9·9	15·1	18·1	20·6	22·7	24·8
3	9·9	15·4	18·3 }	20·5	22·5	24·5
4	10·1	15·1	17·9 }			
			GIRLS			
1	9·5	14·4	17·3	20·3	22·0	24·0
2	9·3	14·2	16·9	19·3	21·3	23·3
3	9·2	14·1	16·7 }	19·5	21·0	23·0
4	9·1	13·6	16·6 }			

Based on the data of normal healthy children.

TABLE X

Gain in weight during the first year of life of matched groups of breast fed(1) and bottle fed(2) infants

Age	First-born babies				Later born babies			
	Number							
	28		28		32		32	
	Breast		Bottle		Breast		Bottle	
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
3 months	5	13	5	9	5	7	5	13
6 months	10	1	10	11	9	10	10	14
9 months	13	1	14	3	12	8	14	0
12 months	15	2	17	1	13	12	16	0

(1) Fully breast-fed at the age of 15, 16 or 17 weeks.

(2) Never breast-fed or taken off the breast before 3 weeks.

TABLE XI

Gain in weight (lb.) at three-monthly intervals from birth to the age of 3 years of children born in different months of the year

Three-monthly intervals	Birth to 3 months	3–6	6–9	9–12	12–15	15–18	18–21	21–24	24–27	27–30	30–33	33–36
January to March ...	5·01 (4)	4·56 (3)	2·93 (3)	1·90 (2)	1·56 (2)	1·24 (3)	1·39 (1)	1·35 (3)	0·71 (3)	1·47 (1)	1·83 (1)	0·85 (3)
April to June	5·50 (2)	4·83 (1)	3·10 (2)	1·86 (3)	1·23 (3)	1·48 (2)	1·10 (2)	0·74 (4)	0·95 (2)	1·25 (3)	0·63 (4)	0·51 (4)
July to September ...	5·60 (1)	4·77 (2)	3·28 (1)	2·29 (1)	1·83 (1)	1·73 (1)	1·04 (4)	1·64 (2)	2·11 (1)	1·47 (1)	1·39 (2)	1·38 (2)
October to December ...	5·13 (3)	4·19 (4)	2·58 (4)	1·59 (4)	1·23 (3)	1·19 (4)	1·07 (3)	2·07 (1)	0·50 (4)	0·41 (4)	1·21 (3)	1·61 (1)

The figures in brackets indicate the order (1=biggest and 4=smallest) of the quarterly weight gain.
Based on the data of all survey children born in January, April, July and October and weighed at the appropriate times.

TABLE XII

Gain in weight since birth according to social class and birth order

Social Class*	6 months	1 year	1½ years	2 years	2½ years	3 years
		Boys *First born*				
	lb.	lb.	lb.	lb.	lb.	lb.
I and II	10·2	16·0	19·2	21·1	23·4	25·7
III	10·5	15·8	18·5	21·3	23·1	25·2
IV	10·7	15·6	18·3	20·3	24·0	25·3
V	10·4	15·5				
		Second and later born				
I and II	10·0	15·1	18·4	20·0	22·0	25·1
III	10·0	15·1	17·9	20·3	22·1	25·0
IV	10·0	15·0	17·6	19·7	21·8	24·1
V	10·2	15·1				
		Girls *First born*				
I and II	9·3	14·7	17·6	19·8	22·4	25·2
III	9·5	14·4	17·4	20·1	21·7	24·2
IV	9·6	14·5	17·1	19·7	21·7	24·4
V	9·6	14·2				
		Second and later born				
I and II	9·0	14·1	16·8	19·3	21·6	24·0
III	9·2	14·0	16·6	19·3	21·4	23·2
IV	9·2	13·4	16·3	19·3	20·5	24·2
V	9·1	13·8				

Based on the data of all the survey children, before exclusions.

* *Key to Social Class:*

I = Professional
II = Managerial
III = Skilled
IV = Semi-skilled
V = Unskilled

TABLE XIII

Gain in weight over 3-monthly intervals

	Boys		Girls	
	Gain	Standard Deviation	Gain	Standard Deviation
	lb.	lb.	lb.	lb.
Birth to 3 months ...	5·5	1·4	4·8	1·2
3– 6 months	4·7	1·3	4·4	1·1
6– 9 „	3·2	1·2	2·8	1·0
9–12 „	2·2	1·2	2·2	1·1
12–15 „	1·5	0·9	1·6	0·8
15–18 „	1·1	0·7	1·3	0·9
18–21 „	1·0	0·7	1·3	0·7
21–24 „	1·2	0·6	1·4	0·9
From 2 to 3 years ...	1·1	0·8	1·3	0·8

Based on the data of samples of normal healthy children.

TABLE XIV

Weights of infants (lb.) up to the age of 3 years found in various surveys

	Northern Industrial Town (Karn and Pearson, 1922)	Scotland (Paton and Findlay, 1926)	Leeds, Glossop, Newcastle (Hill and Magee, 1938)	Glossop (Lewis-Faning and Milligan, 1944 and 1946)		London (Gore and Palmer, 1949)	Aberdeen (Low, 1952)	Lancashire (Simpson, 1952)	Edinburgh (Thomson 1955 *a*, *b*)	Oxford (Acheson, Kemp and Parfit, 1955)	London (Falkner, 1958)	Present Survey
				1934–6	1941–4	BOYS						
Birth ...	—	—	—	—	—	—	7·0	7·5	—	7·6	7·6	7·5
1 year ...	18·8	18·3 19·5 19·8	21·5	22·7	23·0	22·6	20·6	23·4	22·7	22·7	22·4	23·0
2 years ...	—	—	—	—	—	28·3	25·2	—	—	27·8	27·5	28·4
3 years ...	—	—	—	—	—	32·8	28·7	—	31·5	32·2	32·2	32·6
						GIRLS						
Birth ...	—	—	—	—	—	—	6·9	7·2	—	7·3	7·1	7·2
1 year ...	17·1	17·4 17·3 19·0	21·1	20·6	21·4	21·0	19·9	22·1	21·4	21·1	21·3	21·5
2 years ...	—	—	—	—	—	26·9	24·6	—	—	26·1	26·1	27·0
3 years ...	—	—	—	—	—	31·6	29·4	—	30·4	31·0	31·8	31·6

TABLE XV

Standard deviations of attained weights and gains in weight in the first year

Age	Present Survey			
	Attained Weight	Gain* In Weight	Attained Weight	Gain* In Weight
	BOYS		GIRLS	
	lb.	lb.	lb.	lb.
6 weeks	1·33	0·97	1·24	0·96
13 „	1·64	1·38	1·32	1·24
26 „	2·09	1·83	1·87	1·76
52 „	2·49	2·32	2·45	2·26

* The standard deviations of the gains in weight are the averages of those of the gains of infants weighing 6, 7 and 8 lb. at birth, the standard deviation of each pound weight group being calculated separately.

Age	Survey by Parfit (1951)							
	Attained Weight		Gain In Weight		Attained Weight		Gain In Weight	
	BOYS				GIRLS			
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
1 month	1	0	0	15	1	0	0	13
3 months	1	8	1	7	1	5	1	5
6 „	1	12	1	12	1	10	1	10
9 „	2	1	2	1	1	15	1	15
12 „	2	5	2	4	2	2	2	1

TABLE XVI

Guide to a broad interpretation of weight gains over intervals of 1 *and* 3 *months*

Age	Monthly gains		
	Approximate average	Possibly insufficient	Failure to gain Over 1 month
Up to 3 months	About 2 lb.	Less than 1 lb.	Very unusual
3–6 months	„ 1–2 lb.	Less than ½ lb.	Very unusual
6–9 months	„ ½–1 lb.	—	Unusual
9–12 months	„ ½ lb.	—	Somewhat frequent
From 1 to 3 years	Less than ½ lb.	—	Frequent

	3-Monthly gains		
	Approximate average	Possibly insufficient	Failure to gain over 3 months
Up to 3 months	About 5 lb.	Less than about 3 lb.	Very unusual
3–6 months	„ 4–5 lb.	Less than about 2 lb.	Very unusual
6–9 months	„ 3 lb.	Less than about 1 lb.	Very unusual
9–12 months	„ 2 lb.	—	Unusual
From 1 to 3 years	„ 1 lb.	—	Frequent

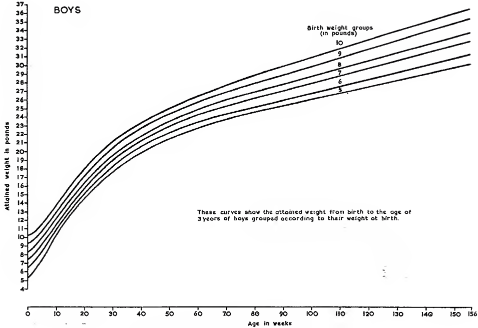
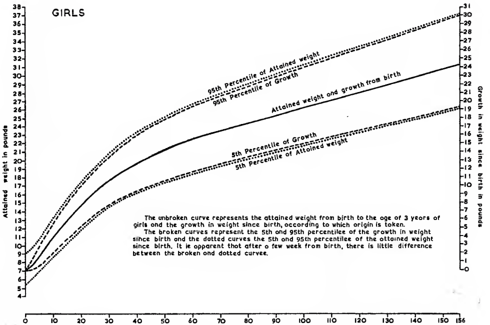


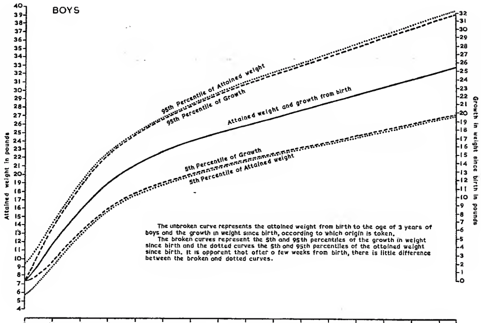
Fig. I(a). Attained weight and growth since birth. Boys.



The unbroken curve represents the attained weight from birth to the age of 3 years of girls and the growth in weight since birth, according to which origin is taken.

The broken curves represent the 5th and 95th percentiles of the growth in weight since birth and the dotted curves the 5th and 95th percentiles of the attained weight since birth. It is apparent that after a few week from birth, there is little difference between the broken and dotted curves.

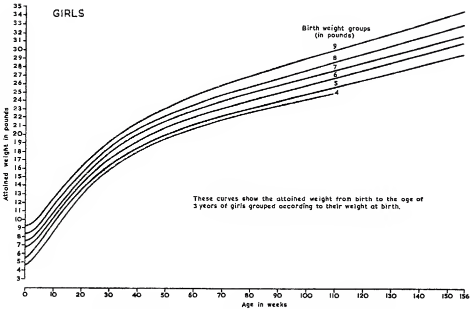
Fig. I(b). Attained weight and growth since birth. Girls.



The unbroken curve represents the attained weight from birth to the age of 3 years of boys and the growth in weight since birth, according to which origin is taken.

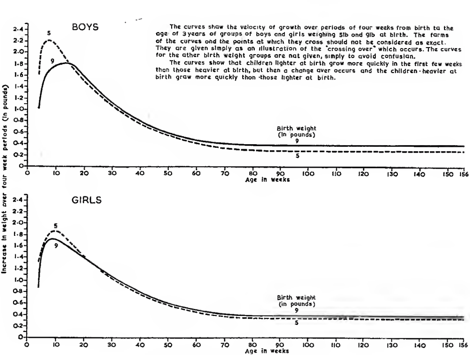
The broken curves represent the 5th and 95th percentiles of the growth in weight since birth and the dotted curves the 5th and 95th percentiles of the attained weight since birth. It is apparent that after a few weeks from birth, there is little difference between the broken and dotted curves.

Fig. II(a). Attained weight according to birth weight. Boys.



These curves show the attained weight from birth to the age of 3 years of girls grouped according to their weight at birth.

Fig. II(b). *Attained weight according to birth weight. Girls.*



The curves show the velocity of growth over periods of four weeks from birth to the age of 3 years of groups of boys and girls weighing 5lb and 9lb at birth. The forms of the curves and the points at which they cross should not be considered as exact. They are given simply as an illustration of the "crossing over" which occurs. The curves for the other birth weight groups are not given, simply to avoid confusion.

The curves show that children lighter at birth grow more quickly in the first few weeks than those heavier at birth, but then a change over occurs and the children heavier at birth grow more quickly than those lighter at birth.

Fig. III. Velocity of growth according to birth weight.

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